(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
22 November 2001 (22.11.2001)

PCT

(10) International Publication Number
WO 01/88807 A2

(51) International Patent Classification[7]: G06F 17/60

(21) International Application Number: PCT/US01/15212

(22) International Filing Date: 10 May 2001 (10.05.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/569,441 12 May 2000 (12.05.2000) US

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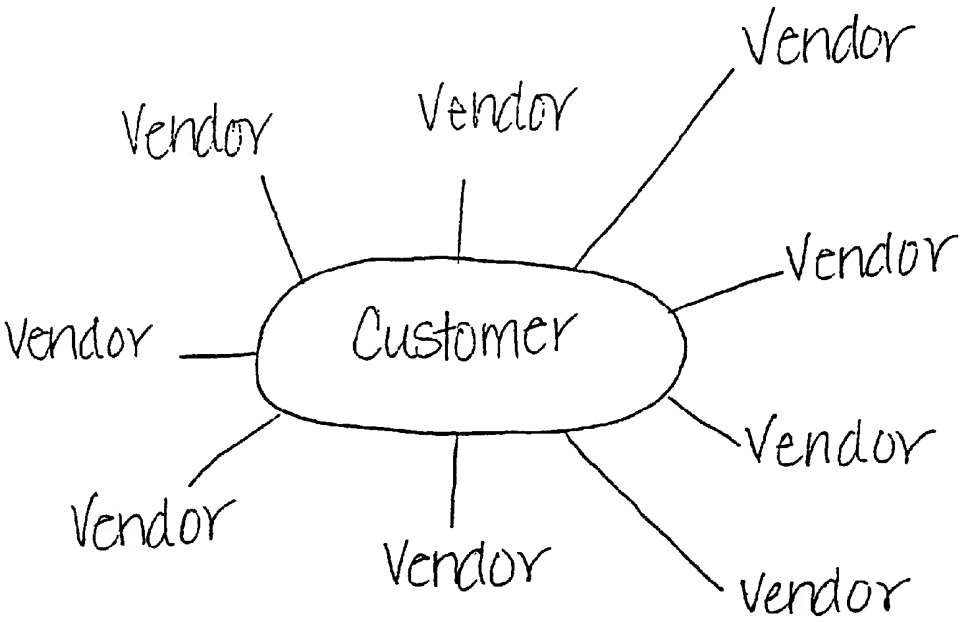
(81) Designated States *(national)*: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ELECTRONIC INTERACTIVE DESIGN COLLABORATION



(57) Abstract: Methods and systems are provided for facilitation of a collaboration between a customer and a vendor on an implementation of a component of the vendor in a product of the customer, comprising a) the vendor providing a first interactive interface and a second interactive interface; b) the customer loading a source data set for the product using the first interface; c) the vendor applying an algorithm to the source data set to produce a results data set; d) the vendor storing at least part of the results data set in a database; and e) the vendor using the second interface to provide at least a portion of the database to the customer.

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ELECTRONIC INTERACTIVE DESIGN COLLABORATION

Field of The Invention

The field of the invention includes electronic interactive collaboration and reports.

Background of The Invention

Electronic devices, their components, and especially the solder points and other interfaces in those components are advantageously designed to optimize competing parameters, including ability to withstand wear and tear, efficiency, and cost-effectiveness. In the past, customers would provide vendors with detailed specifications on specific components that they needed for their products, vendors would typically attempt to produce samples components from the customers' specifications, vendors would give samples of the components to their customers, and the customers would then perform a battery of temperature, stress, moisture and other tests on the samples to determine suitability, reliability, efficiency and so forth. Ultimately, customer feedback on the design of such components would lead the vendors to redesign their components.

From the vendor standpoint, that process is inherently undesirable. For one thing, the arrangement contemplates a hub and spoke type relationship in which the customer is situated at the hub and the vendors are situated at the spokes (see **Figure 1**). The customer is logically in control of the process, but typically does not have the resources to adequately control testing and development.

Figure 2 is a schematic drawing of a typical prior art design collaboration process. In step 210, the customer sends design specifications for specific electronic components to the vendor. The vendor designs a component prototype, in step 220, and sends that prototype to the customer. The customer analyzes the prototype, in step 230, using any available equipment at the customer's facility. The customer may also send the prototype to an independent testing facility, apart from the vendor or customer, to be more extensively tested at the cost of the customer. In step 240, the

customer returns the prototype to the vendor and discusses potential problems and design flaws in the prototype. The vendor, in step 250, makes any necessary design modifications and sends a new prototype to the customer, which begins the process over again at step 230 until a suitable prototype is produced.

It may be more advantageous for a vendor of electronic components to interact with its customers in a manner that takes advantage of the vendor's ability to directly analyze suitability of their components in customer's products. Thus, there is a continuing need to provide systems and methods for accomplishing these goals.

Summary of the Invention

The present invention provides systems and methods for facilitating collaboration between a customer and a vendor with respect to identifying the suitability of using one or more of the vendor's components in one or more of the customer's products. Preferred systems and methods can be conceptualized as a hub and spoke arrangement in which the vendor provides first and second interactive interfaces, the customer uses the first interface to load a source data set for one of its products, the vendor applies an algorithm to the source data set to produce a results data set, and stores at least part of the results data set in a database. The vendor then uses the second interface to provide at least a portion of the database to the customer.

In a particularly preferred embodiment the interfaces comprise web pages on a public access network such as the Internet, and the web pages are used to interactively point users to the source and results data sets. The source data set preferably includes chemical composition and structural information, and may also include functional information. The algorithm is preferably designed to identify likely manufacturing issues, product defects, and may even provide design alternatives. Feedback to the customer via the results data set may occur quite rapidly, in 48 hours or less.

Various objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments of the invention, along with the accompanying drawings in which like numerals represent like components.

Brief Description of The Drawings

Fig. 1 is a schematic of a prior art hub and spoke relationship between a customer and a plurality of vendors with respect to product development.

Fig. 2 is a schematic of several steps in an interaction between vendor and customer in a prior art development of a product.

Fig. 3 is a schematic of a hub and spoke relationship between a vendor and a plurality of customers with respect to product development according to a preferred aspect of the inventive subject matter.

Fig. 4 is a schematic of several steps in an interaction between vendor and customer in a development of a product according to a preferred aspect of the inventive subject matter.

Detailed Description

Figure 3 contemplates a hub and spoke type relationship of the present invention in which the vendor is situated at the hub and the customers are situated at the spokes. The vendor and customer are both in control of the process, through mutual electronic collaboration. Further, the vendor has access to equipment and facilities that can provide control testing and development on the vendor's components as used in the customer's product.

In **Figure 4** a preferred method 400 generally comprises the steps of: a vendor providing a first interactive interface and a second interactive interface 410; a customer loading a source data set for one of its products using the first interface 420; the vendor applying an algorithm to the source

data set to produce a results data set 430; the vendor storing at least part of the results data set in a database 440; and the vendor using the second interface to provide at least a portion of the database to the customer 450.

In step 410 the vendor is preferably a company that dedicates a major portion of its business to designing and/or manufacturing electronic components. An example of a contemplated vendor would be Honeywell Advanced Circuits™. The term "vendor" should, however, be interpreted broadly to include any person, company, or other entity that interacts with customers as set forth herein. Actions said to be taken by a vendor should be interpreted as including acts of its employees, agents, computer systems, and so forth.

The interfaces are preferably Web sites on a wide area public access network such as the Internet. Interfaces on private networks are also contemplated, and in some instances the interfaces may even be limited to particular machines. In general, however, the term "interface" is meant to be interpreted very broadly to include any electronic interface. Contemplated interfaces, for example, may enable human/machine interactions, human/human interactions, or machine/machine interactions. Thus, graphical user interfaces (GUIs) are contemplated, as well as voice-recognition, and standard display screen and keyboard entry systems. The first and second interactive interfaces may or may not be the same interface.

In step 420 a customer is typically a large electronics that manufactures electronic equipment, sometimes referred to as an OEM or Original Equipment Manufacturer. Smaller companies and other entities are also contemplated, however, and the term "customer" should be interpreted broadly.

Contemplated products can be "finished" in the sense that they are ready to be used in industry or by other consumers. Examples of finished consumer products are a television, a computer, a cell phone, a pager, a palm-type organizer, a portable radio, a car stereo, or a remote control. Also contemplated are "intermediate" products such as circuit boards, chip packaging, and keyboards that are expected to be utilized in finished products.

Interaction between vendor and customer as contemplated herein may well be predicated at least in part on the customer's using or anticipating the use of the vendor's components in at least one of the customer's products. The components may be virtually anything, from precursors to adhesives and cements, to packaged chipsets. Either or both of product and component may well comprise a prototype, at any stage of development from conceptual model to final scale-up mock-up. A prototype may or may not contain all of the actual components intended in the final product, and a prototype may have some components that are constructed out of composite material in order to negate their initial effects on other components while being initially tested.

Loading of the source data set will likely be preceded at some point by the loading of customer-specific information such as customer name, company identifier or ID number, address, phone number, fax number, E-mail address, and so forth. Such information may advantageously be used for subsequent authentication.

Preferred source data sets contains numerical, textual, or a combination of numerical and textual information about the product. The source data set may comprise information and design specifications, such as chemical composition data, structural information, and/or functional data.

Chemical composition data includes any data or textual information that describes the chemical makeup or composition of the product or components of the product. Examples of chemical composition data are a) metal to non-metal ratios of the traces, b) polymer/polymer interface information, c) polymer/substrate interface information, d) polymer identification and content, and e) substrate composition.

Structural information and/or data include any data or textual information that describes the structure of the product or of the components of the product. Examples of structural information or data are a) size and shape particulars of the product or the components of the product, b) number of chip packaging layers, c) physical layout of components or chemical constituents in the product, d) density of the traces, e) location of the pads, and f) color of the product or the components of the product.

Functional data and/or information include any data or textual information that describes the functional properties or characteristics of the product or components of the product. Examples of functional data are a) impedance, b) capacitance, c) noise, d) noise susceptibility, e) moisture susceptibility, f) resistance, g) voltage, and h) current.

Loading of the source data set can be advantageously accomplished using a browser link at the first interactive interface to point the interface to a data file, or by typing data into a plurality of data boxes that are designed to accept and/or store large sets of data or textual information, such as that which is contained within the source data set.

In step 430, the vendor applies an algorithm to the source data set to ultimately produce a results data set. Generation of the results data set occurs from the manipulation of a plurality of intermediate data sets that are generated from the source data set.

An intermediate data set is a data set that results from an intended, methodical and predictive mathematical, theoretical or digital manipulation of the information in the source data set. It is contemplated that the application of a mathematical, theoretical or digital manipulation to the information in the source data set can be defined as an application of an "algorithm". It is contemplated that the method and systems described in U.S. Patent Application Serial No.: 09/543628 would be a suitable example of a mathematical algorithm that simulates polymer/polymer or polymer/substrate interfaces and is herein incorporated by reference.

The intermediate data set may comprise purely numerical information, a mixture of numerical and qualitative information, or purely qualitative information. The phrase "qualitative information" means information that is not numerical and is, in most cases, is in the form of textual information. In preferred embodiments, the intermediate data set comprises a mixture of numerical and qualitative information.

Mathematical, theoretical or digital manipulation of the information in the source data set may be designed to simulate or identify manufacturing defects, product defects and/or design alternatives. Manufacturing defects are generally those defects that result from a problem in the

manufacturing process, such as a faulty machine, high humidity during the manufacturing process, or lack of temperature control during the manufacturing process. Product defects are generally those defects physically present in the product itself, such as cracks, fracturing at interfaces, or faulty connections. Design alternatives or modifications are generally characterized as summaries of the problems present in the process or the product. Suggested modifications to the process or product or suggested alternative embodiments can be presented as part of the design alternatives summary. It is contemplated that the vendor is the appropriate entity to evaluate the problems present and suggest design alternatives or modifications.

The intermediate data set is analyzed for a set of predetermined markers or "errors". Predetermined markers or "errors", in this case, may be any numerical or descriptive term that the vendor recognizes as being an important or significant identification mark present in the intermediate data set after application of the algorithm or set of algorithms. Examples of predetermined markers are a) temperature data which exceeds industry standards, b) resistance, impedance, or current data that does not meet industry minimums or standards, c) data that would suggest the likelihood of plasma sparkover, and d) data that would suggest the likelihood of cracking, fracturing or complete degradation of polymer/polymer interfaces or polymer/substrate interfaces.

Once the vendor identifies the predetermined markers, the intermediate data set can be categorized and then ordered based on those predetermined markers, in order to form the results data set. It is contemplated that the intermediate data set can be ordered by using typical spreadsheet software, such as Microsoft Excel™ or QuattroPro™.

In step 440, once the intermediate data set is categorized and ordered, at least part of the results data set can then be left in the original database or transferred into another database, depending on the type of information produced. The term "database", as used herein, means a large collection of data organized especially for rapid input search and/or retrieval, as by a computer. Contemplated databases can be spreadsheets, such as Excel™ or QuattroPro™, or relational

database systems, such as Microsoft Access™, Oracle Server™, or Microsoft SQL Server™. Databases may also be linked to other databases within or outside of the system defined herein.

The results data set includes information related to design improvement, design errors, and overall design efficiency of the product. The results data set can be any information that is customized and generated based on the particular design needs of the customer regarding the product or to the particular design specifics of the product.

In step 450, the results data set is converted into an electronically accessible format and is displayed to the customer. The results data set can be converted into electronic format by "Web-enabling" the database or collection of databases. The term "Web-enabled" means that the database is accessible through or by the customer performing a set of commands at a Web browser or Web site, such as by accessing predetermined choices from a list box or via query language. The Web browser or Web site can be used to access a public network and/or private network, such as the Internet.

The results data set is preferably displayed or otherwise made available to the customer or made available to the customer within a relatively short period after the source data set is transmitted to the vendor. The results data set may advantageously be made available to the customer within 72 hours of the customer inputting the source data, more preferably within 36 hours, and even more preferably within 24 hours.

Examples

Example 1

The customer creates a printed circuit board (PCB) design. The design is electronically sent to the vendor. The vendor analyzes the PCB design, checking to verify the design will meet the customer's specification after manufacturing and can be manufactured in the most economical way. The output from this analysis process is reported back to the customer via a web-based report. The output is usually presented to the customer within 24 hours of the design being electronically sent to the vendor. The customer modifies the design based on this feedback and sends new design data to the vendor that is ready for manufacturing.

Example 2

Customer A (a large network systems OEM) creates a printed circuit board (PCB) design. The design is electronically sent to the vendor (Honeywell Advanced Circuits or HAC). The vendor (HAC) analyzes the PCB design by running several algorithms, including those algorithms that search for the following errors: Data package sent more than once; Wrong data package sent; Artwork files unreadable; Aperture list unreadable; Readme file unreadable; Drill file unreadable; NC Rout/Mill data unreadable; CAD NET list unreadable; Drawing files unreadable; ZIP/TAR file unreadable; Cu to Cu spacing below minimum; Cu to Non Plated hole spacing below minimum; Cu to board edge spacing below minimum; Same net spacing problems; Nomenclature on pads; Text line width oversized; Text line width undersized; Nomenclature in hole(s); Solder mask dams below minimum; Clearance for NP (non plated) holes below minimum; Missing solder mask clearance; Exposed circuits; Vias covered on one side and clearanced on other side; Misregistered clearance; Wrong hole count; Missing hole counts; Dimension does not match artwork data; Dimension does not match drill data; Missing dimensions; Array print missing; Missing radii; Double drill hit; Missing drill holes; Extra holes in drill file; Landless holes; Annular ring below minimum; Plated hole partially in/out of copper shield; Netlist provided does not match artwork data netlist; Part number or rev. mismatch between artwork and prints; No specification referenced; Tolerance for

plated hole(s) unacceptable; Tolerance for NP hole(s) unacceptable; Tolerance for warp and twist unacceptable; No specification for gold plating thickness; No hole tolerance specifications supplied; No board thickness specifications supplied; Tolerance for board edge unacceptable; Finished thickness tolerance unacceptable; and Impedance on print not supported by design. The analysis of the PCB design checks to verify the design will meet customer A's specification after manufacturing and can be manufactured in the most economical way.

Analysis reveals that the PCB design as specified will not meet customer A's impedance requirements. HAC electronically reports back to customer A the necessary changes required to manufacture the PCB meeting the impedance requirement. Customer A modifies the design based on this feedback and sends new design data ready for manufacturing.

Example 3

Customer B (a large global products OEM) creates a printed circuit board (PCB) design. The design is electronically sent to the vendor (Honeywell Advanced Circuits or HAC). The vendor (HAC) analyzes the PCB design by running several algorithms, including those algorithms that search for the following errors: Data package sent more than once; Wrong data package sent; Artwork files unreadable; Aperture list unreadable; Readme file unreadable; Drill file unreadable; NC Rout/Mill data unreadable; CAD NET list unreadable; Drawing files unreadable; ZIP/TAR file unreadable; Cu to Cu spacing below minimum; Cu to Non Plated hole spacing below minimum; Cu to board edge spacing below minimum; Same net spacing problems; Nomenclature on pads; Text line width oversized; Text line width undersized; Nomenclature in hole(s); Solder mask dams below minimum; Clearance for NP (non plated) holes below minimum; Missing solder mask clearance; Exposed circuits; Vias covered on one side and clearanced on other side; Misregistered clearance; Wrong hole count; Missing hole counts; Dimension does not match artwork data; Dimension does not match drill data; Missing dimensions; Array print missing; Missing radii; Double drill hit; Missing drill holes; Extra holes in drill file; Landless holes; Annular ring below minimum; Plated

hole partially in/out of copper shield; Netlist provided does not match artwork data netlist; Part number or rev. mismatch between artwork and prints; No specification referenced; Tolerance for plated hole(s) unacceptable; Tolerance for NP hole(s) unacceptable; Tolerance for warp and twist unacceptable; No specification for gold plating thickness; No hole tolerance specifications supplied; No board thickness specifications supplied; Tolerance for board edge unacceptable; Finished thickness tolerance unacceptable; and Impedance on print not supported by design. The analysis of the PCB design generally verifies the design will meet the customer B's specification after manufacturing and can be manufactured in the most economical way.

Analysis reveals that the PCB design as specified will result in a component to PCB mis-registration. This will result in the inability to attach the component to the PCB. HAC electronically reports back to customer B necessary changes required to manufacture the PCB meeting the component "footprint" requirement. Customer B modifies the design based on this feedback and sends new design data ready for manufacturing.

The overall advantages of the present invention can readily be seen. The number of steps of the prior art method previously described can be reduced (at least one step removed from the process), and in some cases, can be significantly reduced (at least three steps removed from the process). The preferred embodiments of the present invention can be performed via an electronic graphical user interface, thus preserving natural resources. The cycle time - meaning the time from design data acquisition to results data set presentation - can also be reduced over prior art methods. Still further, everyone working on the project can access data regarding the source data set and/or results data set. And yet another advantage is that the overall effort exerted in prior art methods to go from design to pre-production can be minimized.

Thus, specific embodiments and applications of electronic interactive design collaboration and reports have been disclosed. It should be apparent, however, to those skilled in the art that many more modifications besides those already described are possible without departing from the inventive concepts herein. The inventive subject matter, therefore, is not to be restricted except in the spirit of the appended claims. Moreover, in interpreting both the specification and the claims, all terms should be interpreted in the broadest possible manner consistent with the context. In

particular, the terms "comprises" and "comprising" should be interpreted as referring to elements, components, or steps in a non-exclusive manner, indicating that the referenced elements, components, or steps may be present, or utilized, or combined with other elements, components, or steps that are not expressly referenced.

CLAIMS

What is claimed is:

1. A method of facilitating a collaboration between a customer and a vendor on an implementation of a component of the vendor in a product of the customer, comprising:

the vendor providing a first interactive interface and a second interactive interface;

the customer loading a source data set for the product using the first interface;

the vendor applying an algorithm to the source data set to produce a results data set;

the vendor storing at least part of the results data set in a database; and

the vendor using the second interface to provide at least a portion of the database to the customer.

2. The method of claim 1, further comprising the vendor having a major portion of its business as designing electronic components.

3. The method of claim 2, wherein the electronic components are circuit boards.

4. The method of claim 1, wherein the product is a consumer product.

5. The method of claim 1, wherein the product is an intermediate product.

6. The method of claim 1, wherein the step of providing a first interactive interface comprises the designing of a Web site that includes the first interactive interface.

7. The method of claim 1, wherein the first interactive interface is included in a Web site having a URL address.

8. The method of claim 1, wherein the step of loading a source data set comprises using a browser link to point the first interactive interface to a data file.

9. The method of claim 1, wherein the step of loading a source data set comprises typing data into a plurality of data boxes.

10. The method of claim 1, wherein the source data set includes both chemical composition data and structural information.

11. The method of claim 1, wherein the source data set includes functional information.

12. The method of claim 11, wherein the chemical composition data and structural information comprises at least one of polymer identification and content, substrate composition, density of traces, location of pads, and location of chemical constituents in the component.

13. The method of claim 13, wherein the functional information comprises at least one of impedance, capacitance, noise, noise susceptibility, moisture susceptibility, resistance, voltage and current.

14. The method of claim 1, wherein the algorithm is a predictive mathematical model that identifies at least one of a manufacturing defect and a product defect.

15. The method of claim 1, wherein the algorithm is a predictive theoretical model that identifies a design alternative.

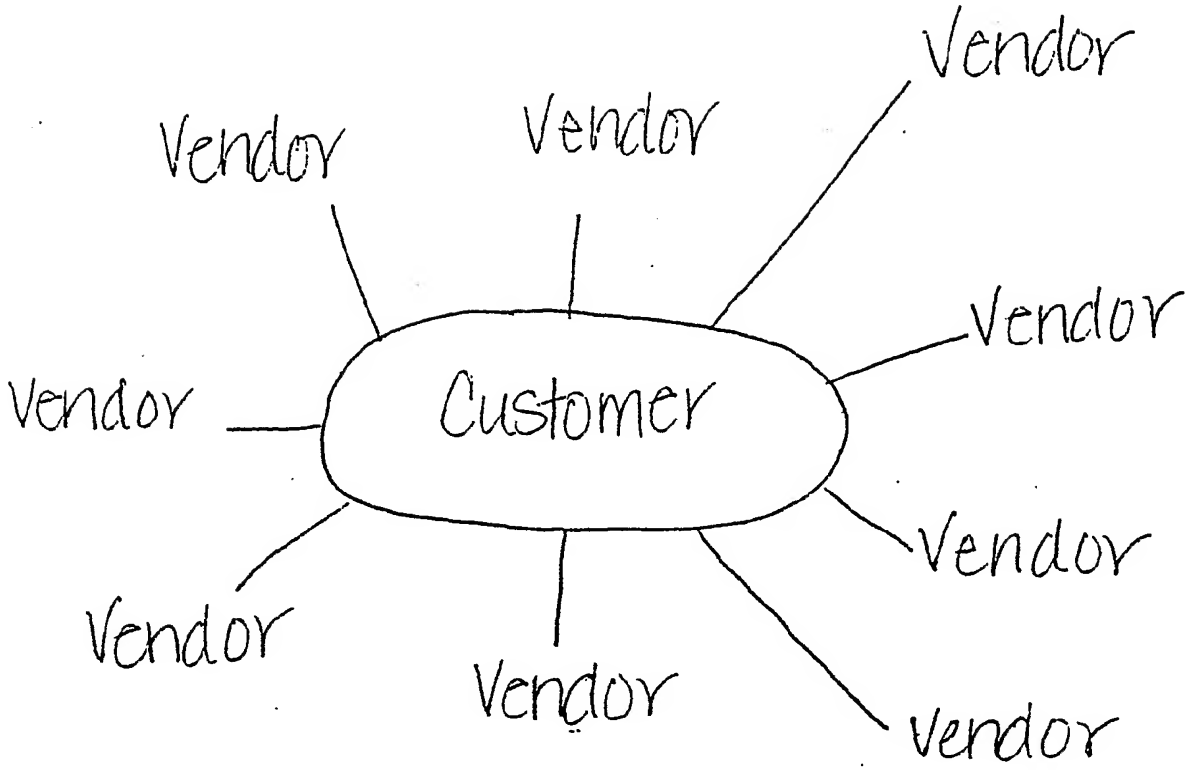
16. The method of claim 1, wherein the results data set comprises information related to manufacturing defects, product defects and contemplated design alternatives.

17. The method of claim 1, wherein the vendor applying an algorithm to the source data set produces an intermediate data set that is further used to produce the results data set.

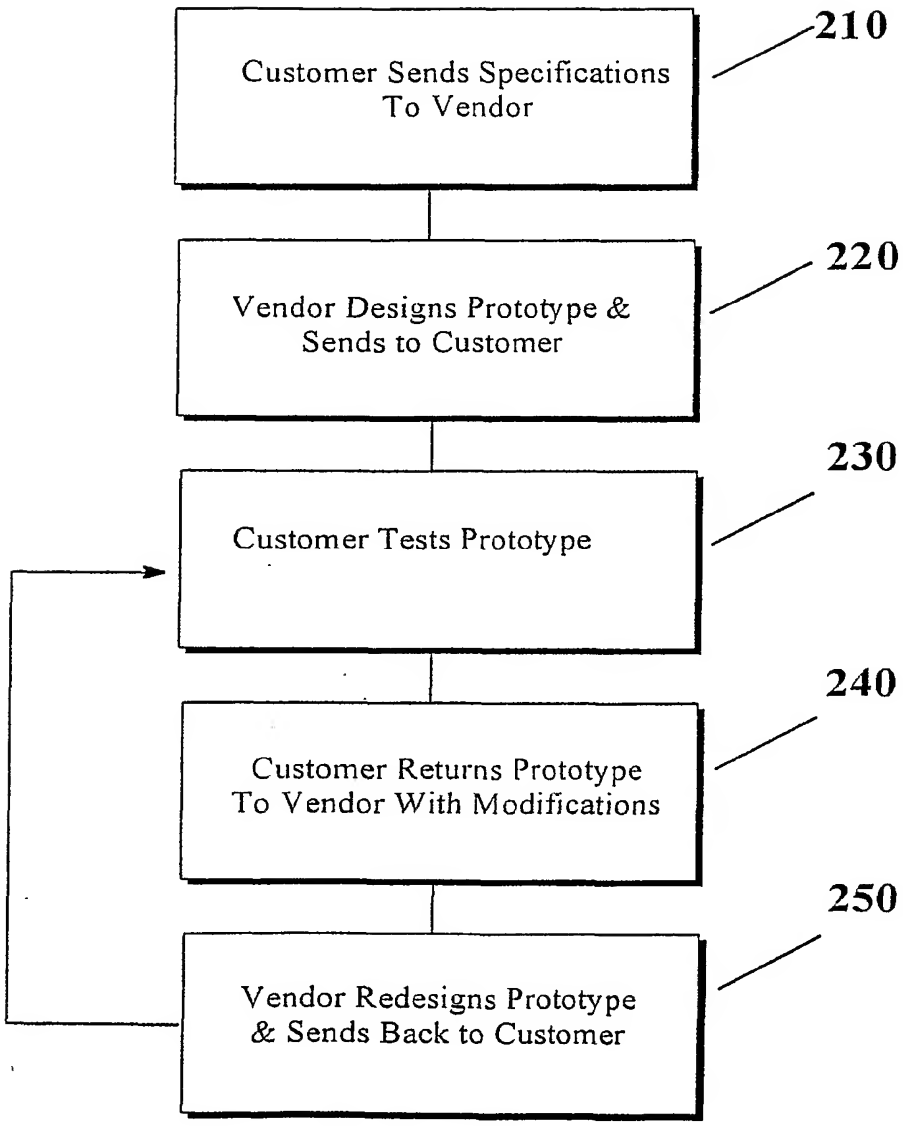
18. The method of claim 17, wherein the intermediate data set comprises numerical information, a mixture of numerical and qualitative information, or purely qualitative information.

19. The method of claim 1, wherein the step of using the second interactive interface further comprises implementing a customer identifier system such that the customer inputs a customer identifier as a condition of accessing the results data set.

20. The method of claim 1, wherein the step of using the second interface to provide at least a portion of the database to the customer occurs within 24 hours of the customer imputing the source data set into the first interactive interface.



Prior Art Figure 1



Prior Art Figure 2

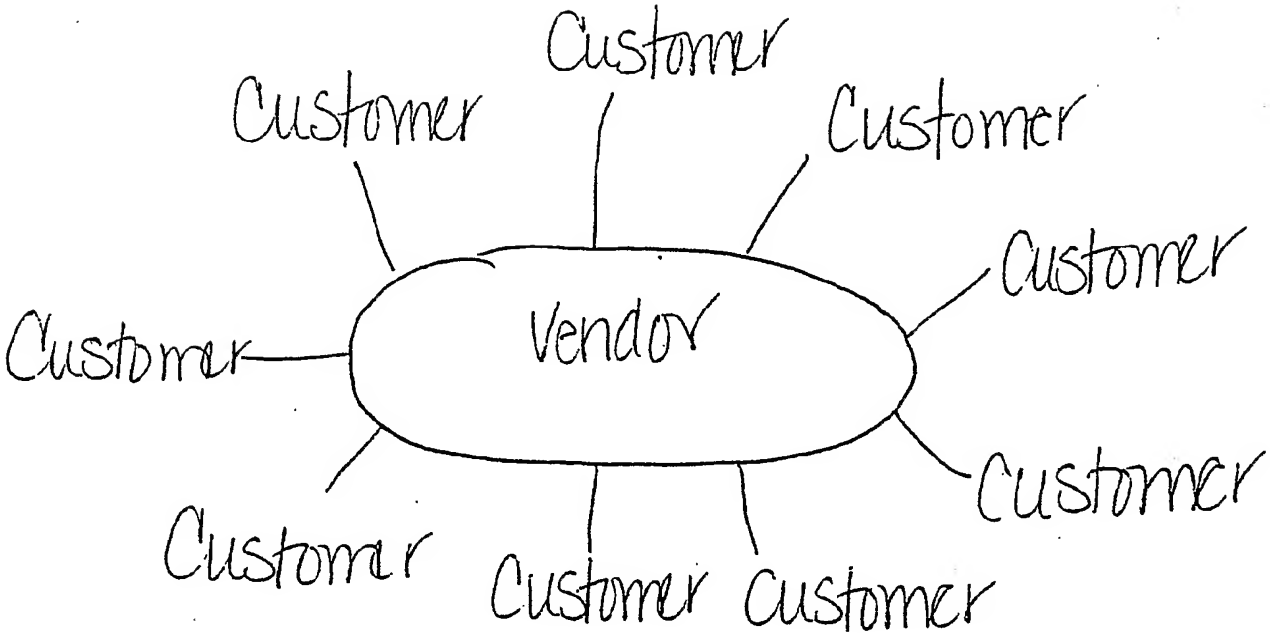

Customer
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Figure 3

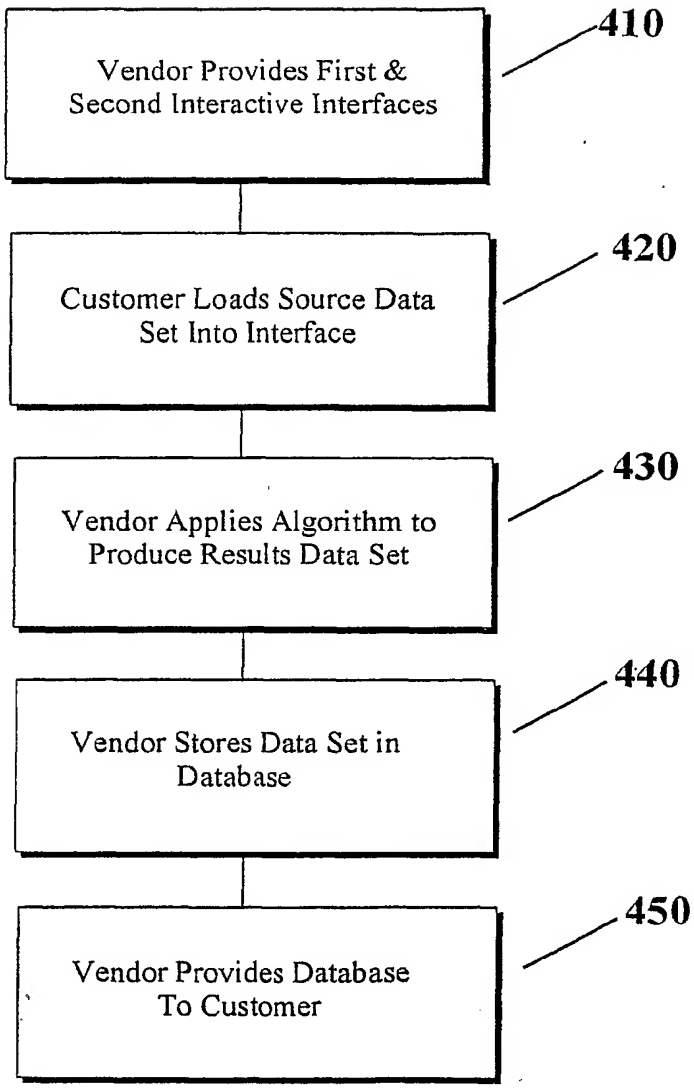
Vendor Provides First & Second Interactive Interfaces
410
Customer Loads Source Data Set Into Interface
420
Vendor Applies Algorithm to Produce Results Data Set
430
Vendor Stores Data Set in Database
440
Vendor Provides Database To Customer
450

FIGURE 4